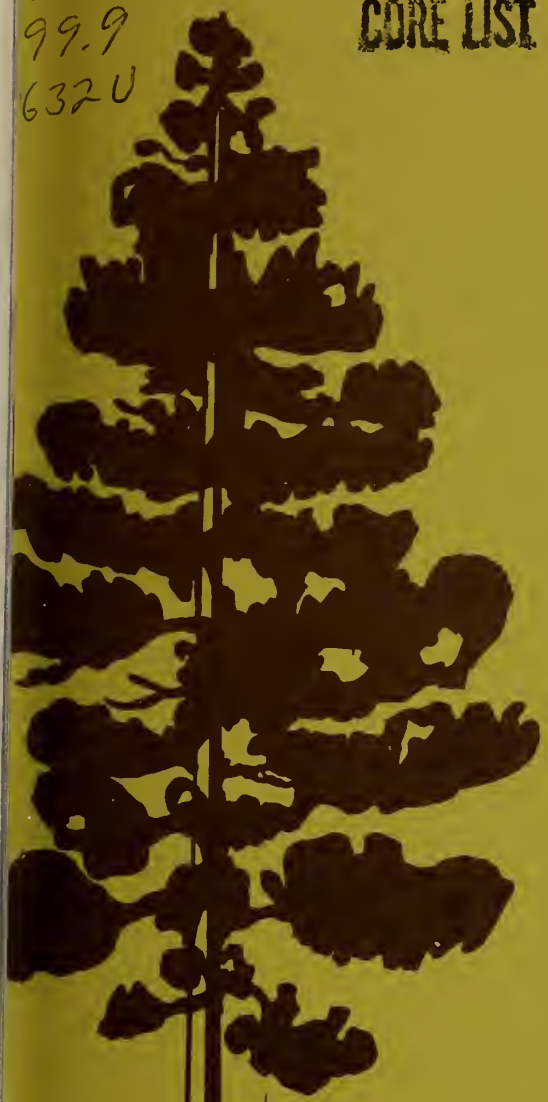
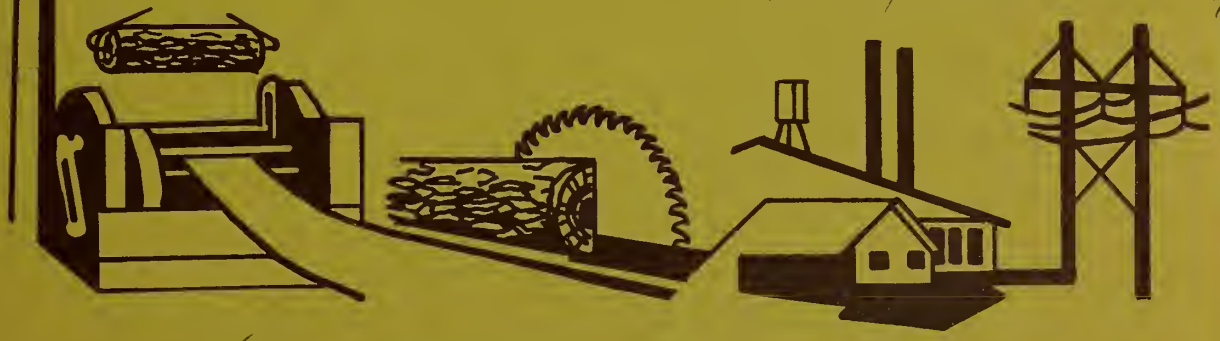


BLACK HILLS PONDEROSA PINE TIMBER: Poles, Saw Logs, Veneer Logs, Stud Logs, or Pulp?



by Vern P. Yerkes

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Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture
Fort Collins, Colorado

Abstract

A multiproduct analysis indicates that public lands contain gross volumes per acre of 4,944 board feet (fbm) of saw logs, 4,680 fbm of veneer logs, or 3,052 fbm of stud logs if inventoried for these products individually. If inventoried simultaneously for highest multiproduct potentials, however, they contained gross allocated volumes of 881, 3,165, and 143 fbm per acre for each product, respectively. These analyses demonstrate the usefulness of multiproduct evaluation techniques in evaluating utilization alternatives.

Oxford: 228:831.4:832.10,20:861.0. **Keywords:** Poles, saw logs, veneer logs, stud logs, pulp, *Pinus ponderosa.*

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BLACK HILLS PONDEROSA PINE TIMBER:

Poles, Saw Logs, Veneer Logs, Stud Logs, or Pulp?

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BLACK HILLS PONDEROSA PINE TIMBER: Poles, Saw Logs, Veneer Logs, Stud Logs, or Pulp?

Vern P. Yerkes

Introduction

Describing a timber stand in terms of board-foot or cubic-foot volume alone does not adequately describe its potential as raw material for multiproduct industry. Total cubic volume estimates may be useful to pulpwood producers without much additional information, but would be of little value to plywood producers without some definition of log size and quality. Likewise, the number of board feet in a stand would be useful information to an experienced local sawmiller, but would have considerably less value to a producer of utility poles.

A multiproduct inventory system devised by Barger and Ffolliott (1970) permits evaluation of a timber stand for several products from one set of field inventory data. Their system can be coupled with a computer program (MULTI), developed by Heidt et al. (1971), to evaluate the stand for virtually any primary product for which a set of grading specifications can be defined.

In this Paper, two segments of the Black Hills ponderosa pine resource were evaluated by these combined multiproduct field inventory and data processing systems. The analyses apply the following currently accepted grading systems for poles and saw logs, and preliminary grading systems for veneer logs and stud logs. The output of the computer program described the two forest areas in terms of average volumes per acre suitable for each product and product grade. Analysis of a forest resource for potential alternative uses will permit timber managers and processors to identify the most profitable products or product mixes, and will help them make management adjustments to achieve maximum benefits from the resource.

Product Specifications

Commercial Poles

The specifications and dimensions used in this study are a conversion of American Standard pole specifications (American Standards Association 1963) to outside-bark diameter dimensions for ponderosa pine poles. The converted table of dimensions was developed by Bert Jennings, Forester, Southwest Forest Industries, for use in identifying and selecting ponderosa pine poles in the field. Specifications and dimensions follow:

1. All trees 9.0 through 20.9 inches d.b.h. **with acceptable pole form**, will be considered potential pole material.
2. Defects that are inadmissible in commercial poles include
   —sweep (deviation greater than ⅓ d.b.h.),
   —major crook (deviation greater than ½ pole diameter at crook),
   —knots larger than 4 inches in diameter dead or green),
   —knot whorls or clusters aggregating more than 8 inches of knot diameter within 1 linear foot,
   —fork,
   —heart rot,
   —lightning scar,
   —fire scar.
3. For trees meeting minimum merchantable specifications, stem length to the first limiting defect will be recorded (such as length to first inadmissible knot, and so forth). Such defects as fork, crook, and fire scar, if located near the butt or top of the stem, may not eliminate the pole but require a reduction of acceptable pole length.

Table 1.--Pole specifications for ponderosa pine, minimum diameter, inside and outside bark

Pole length, (ft)	Pole class 1	2	3	4	5	6	7
	d.b.h., o.b., inches						
16					9.9	9.4	9.0
18			11.6	11.0	10.3	9.7	9.4
20			12.1	11.3	10.7	10.0	
25			13.2	12.4	11.8		
30		14.8	14.0	13.2	12.7		
35		15.6	14.8	13.8	13.4		
40		16.5	15.6	14.7	14.2		
45		17.2	16.3	15.3	14.8		
50	18.3	17.8	16.9	16.1			
55	19.5	18.5	17.7				
60	20.0	19.0	18.2				
	- - - - - -		*Top, inches*			- - - - - - -	
d.i.b.	10.0	9.4	8.8	8.3	7.8	7.0	6.0
d.o.b.	12.0	11.3	10.6	10.0	9.4	8.4	7.2

The range of merchantable diameters and heights of commercial poles to be expected from ponderosa pine in the Black Hills can be approximated from table 1.

Saw Logs

The grading specifications used for saw logs (Gaines 1962) were:

1. Logs 6.0 inches and larger in scaling diameter are considered potential saw logs. All trees 9.0 inches and larger in d.b.h. are considered sawtimber trees.
   All grading specifications are written for 16-foot log lengths. The same specifications apply to shorter logs in proportion to their length.
2. All logs meeting the minimum merchantability standards are graded according to the Improved Ponderosa Pine — Sugar Pine Log Grades (Gaines 1962). Grades criteria include:

   Panel — log surface area one-fourth the circumference and 4 feet long.
   Primary defect — log knots, including limbs, limb stubs, overgrown knots, etc.
   Secondary defect — scars, burls, forks, crooks, cankers, etc.

   Grading specifications for four of the five grades are abbreviated below. (Grade 4 logs, as described by Gaines, rarely occur in Black Hills ponderosa pine. Grade 4 was therefore omitted in this analysis.)

	Defects Permitted	
Grade	**Primary**	**Secondary**
1	One log knot not over ½ inch in diameter	Confined to three panels or less
2	Confined to four panels or less	Secondary plus primary confined to six panels
3	Six panels free of all grading defects	
4	All other logs with net scale of ⅓ or more of gross scale	

Veneer Logs

Preliminary specifications used for grading veneer logs (Yerkes and Woodfin 1972) were:

1. Logs 8.0 inches and larger in scaling diameter are considered potential veneer logs (8-foot block lengths are required).
2. Logs will be graded by the following specifications:

   Grade 1 — blocks believed capable of yielding a preponderance of C and better grades of veneer:
   (1) Dead knots must be equal to or less than 2 inches in horizontal diameter.
   (2) Live knots must be less than 2 inches in horizontal diameter.

   Grade 2 — blocks believed capable of yielding a preponderance of D grade veneer:
   (1) Dead knots greater than 2 and less than 4 inches in horizontal diameter.
   (2) Live knots — no limit.

   Unacceptable — if logs include:
   (1) Dead knots greater than 4 inches horizontal diameter.
   (2) Crook greater than ⅓ top diameter of the 8-foot block.
   (3) Fork or distorted grain associated with fork.
   (4) Fire scar.
   (5) Lightning scar.
   (6) Decayed wood where lathe chucks strike block.

Stud Logs

Preliminary specifications used for grading stud logs (Barger and Ffolliott 1970) were:

1. Logs 6.0 through 16.9 inches in scaling diameter will be considered potential stud logs. All specifications are to be applied to 8-foot log lengths.
2. Logs that meet the basic size and quality requirements for stud logs will be graded by the following specifications:

   Grade 1 — attempts to identify stud logs from which a high proportion of SELECT and CONSTRUCTION grade studs can be recovered:
   (1) Dead knots allowed to 1 inch in diameter.
   (2) Green knots allowed to 2 inches in diameter.
   (3) Total number of knots cannot exceed 16.

   Grade 2 — attempts to identify stud logs from which a high proportion of STANDARD grade studs can be recovered:
   (1) Dead knots allowed to 2 inches in diameter.
   (2) Green knots allowed to 2 inches in diameter.
   (3) Total number of knots cannot exceed 32.

Grade 3 — attempts to identify stud logs from which a high proportion of UTILITY and ECONOMY grade studs can be recovered:
(1) Dead knots allowed to 2 inches in diameter.
(2) Green knots allowed to 3 inches in diameter.
(3) Total number of knots unlimited.

Unacceptable — if logs include:
(1) Dead knots greater than 2 inches in diameter.
(2) Green knots greater than 3 inches in diameter.
(3) Sweep (deviation greater than one-third scaling diameter).
(4) Crook.
(5) Fork or distorted grain resulting from fork.
(6) Massed pitch.
(7) Fire or lightning scar.
(8) Heart rot.

Data Collection and Analysis

Field data were collected from trees 5.0 inches d.b.h. and larger from permanent sample plots established in pole and sawtimber stands. The basic system described by Barger and Ffolliott (1970) was used, although some modifications were necessary to provide data in a form useful for a plywood feasibility study. Data are from two sources:

1. **General Ownership Lands** — a 1968 resurvey of the fixed-plot permanent sample plots in the Black Hills National Forest (USDA,FS), Custer State Park (State of South Dakota),[2] and the Bureau of Land Management (USDI) Exemption Area around Lead and Deadwood, South Dakota.
2. **Custer State Park Lands** — an intensive timber survey in 1969 by the South Dakota State Forester's Office, based on a variable-plot permanent sampling system for the Park that used plot establishment and measurement techniques outlined by the USDA Forest Service Survey Project at Intermountain Forest and Range Experiment Station, Ogden, Utah.

Both surveys used the same multiproduct evaluation system, but because sampling systems were different, data cannot be combined. The computer program MULTI (Heidt et al. 1971) was adjusted to accept the data in the format as collected.

Stem Characteristics

Stem characteristics included in field inventory data for multiproduct evaluation of Black Hills ponderosa pine were:

Sweep — gradual bend in the merchantable tree tree stem.
Class 1 — deviation of the stem centerline from a straight line is less than the d.b.h. of the tree.
Class 2 — deviation of the stem centerline from a straight line is greater than the d.b.h. of the tree.

Crook[3] — an abrupt bend in the merchantable stem.
Class 1 — deviation of the centerline of the stem is less than one-third of the small-end diameter of the 8-foot section containing the crook.
Class 2 — deviation of the centerline of the stem is between one-third and one-half of the small-end diameter of the 8-foot section containing the crook.
Class 3 — deviation of the centerline of the stem is greater than one-half the small-end diameter of the 8-foot section containing the crook.
Location — location of crook by half-log position.

Fork — point where merchantable stem divides into two or more stems of nearly equal size.
Location — location of fork by half-log position.

Fire or basal scar — distortion of the lower portion of the merchantable stem by callous growth and/or exposed wood resulting from fire or mechanical damage.
Class 1 — distortion or exposed wood extends less than one-fourth the circumference of the tree.
Class 2 — distortion or exposed wood extends over more than one-fourth the circumference of the tree.

Rot[3] — decayed wood visible behind or in fire or basal scars. Only visible decay is recorded.

[2]*The General Ownership survey included only eight 1/5-acre plots on the Custer State Park. The effect of these plots in the General Ownership survey is considered minimal. The more intensive survey made by the South Dakota State Forester's Office is therefore used to characterize the Park stands.*

[3]*Indicates a deviation from the basic inventory method described by Barger and Ffolliott (1970). Lean was not considered a defect and was not recorded.*

Lightning Scar — vertical or spiraled strip of exposed wood and/or callous growth resulting from a lightning strike.
Class 1 — damage to the merchantable stem is limited to one one-quarter face of the merchantable stem.
Class 2 — damage to the merchantable stem extends into more than one one-quarter face of the stem.
Knots — side branch extending from the merchantable stem.
Live — branch with tight bark, live needles on twigs.
Dead — branch stub with no live needles.

Product and Grade Combinations

Eleven separate combinations of product and grade were evaluated, both as independent products and on a product priority basis.

Independent product evaluations were made by evaluating all tree stems in the stand for only one product at a time. Estimated total resource volume per acre is reported alternatively as that suitable for each individual product.

Product priority evaluations were made by evaluating each tree or stem section for its suitability for each product, beginning with the highest valued product and progressing to the lowest. Each stem or stem section was allocated to the highest valued product for which it qualified. The total resource volume per acre is reported collectively as the proportion of stand volume allocated to each product considered.

Product-grade combinations were ranked in the following order of decreasing value:

1 — Poles
2 — Grade 1 saw logs
3 — Grade 2 saw logs
4 — Grade 3 saw logs
5 — Grade 1 veneer logs
6 — Grade 2 veneer logs
7 — Grade 1 stud logs
8 — Grade 2 stud logs
9 — Grade 3 stud logs
10 — Grade 5 saw logs
11 — Pulpwood

Volumes for trees and logs were calculated from Black Hills ponderosa pine volume tables (Myers 1964), with merchantable heights calculated from total heights (Van Deusen 1967), and volumes distributed by log position through the use of taper tables (Woodfin 1960). Both gross product volume and volume adjusted for visual scaling defects (reduced volume) were determined. Defects that affect usable volume, and average scale deductions for each class of defect, were calculated as shown in table 2.

Grading specifications used for poles were adapted from Association specifications for wood poles (American Standard Association 1963) and visually applied to the trees during data collection. Grading specifications used for saw log grades were those developed by Gaines (1962) and included in the basic MULTI program. Veneer blocks were evaluated according to knot size and defect specifications outlined by Yerkes and Woodfin (1972). The basic MULTI program was adjusted to include changes in veneer log quality criteria. Stud logs were evaluated according to knot size and defect specifications outlined by Barger and Ffolliott (1970), and included in the program.

Standard errors were calculated for the General Ownership lands by means of cluster analysis techniques with unequal number of subplots, developed by J. L. Kovner, Rocky Mountain Station biometrician. Standard errors

Table 2.--Percent scale reduction applied to product volume for defects

Defect type and degree	Poles[1]	Saw log[2]		Veneer log[2]	Stud log[3]	Pulp
		16 ft	8 ft			
SWEEP:						
Class 1	100	0	0	0	0	0
Class 2	100	20	20	0	0	0
CROOK:						
Class 1	0	25	50	50	50	0
Class 2	0	25	50	100	100	0
Class 3	([4])	25	50	100	100	0
FORK	([4])	25	50	100	100	0
FIRE OR BASAL SCAR:						
Class 1	([4])	0	0	([5])	0	([6])
Class 2	([4])	13	0	([5])	25	([6])
KNOTS(Inches)						
Live ≥4.0	100	0	0	0	100	0
Dead ≥4.0	100	0	0	0	0	0
Dead ≥4.0	100	0	0	100	0	0
Dead ≥3.0	([7])	0	0	0	100	0
ROT	100	0	0	([5])	([8])	0
LIGHTNING SCAR:						
Class 1	100	25	25	100	25	0
Class 2	100	50	50	100	50	0

[1]9.0 to 20.9 inches, d.b.h.
[2]9.0+ inches, d.b.h.; 8-ft veneer log length.
[3]5.0 to 22.9 inches, d.b.h.; 8-ft log length.
[4]5-ft reduction in pole height if in first or last 8-ft section; 100 percent if in center 8-ft section.
[5]100 percent if rot is in conjunction with fire scar; 25 percent of degree 2 fire scar and no rot.
[6]50 percent of butt section.
[7]Not applicable.
[8]100 percent if rot is in the butt section.

for Custer State Park lands were calculated with individual plot data considered as random sample observations.

Results and Discussion

Pole and sawtimber stands sampled in the 1968 survey of the General Ownership lands contained an average volume of 4,900 fbm gross Scribner scale per acre[4] in trees 9.0 inches d.b.h. and larger (fig. 1, table 3). When evaluated for products other than lumber, these stands contained gross volumes of about 4,700 fbm of veneer logs or 3,100 fbm of stud logs per acre. Volume deductions for visible defects were 9, 4, and 9 percent, respectively, for the three products.

If, on the other hand, each log or block were to be evaluated for its highest valued product, the same stands (fig. 2, table 3) would contain 10 commercial poles,[5] 4,190 fbm of logs — 21 percent saw logs, 76 percent veneer logs, and 3 percent stud logs — and 147 ft^3 of pulpwood per acre. Board-foot volume differences in table 3 are the result of shifting potential saw log material between alternative products.

Timber stand data of the same type were collected for Custer State Park by the South Dakota State Forester's Office during the initiation of a permanent sampling system for the Park. These data show that Custer State Park stands differ considerably from stands sampled on General Ownership lands. They contain smaller gross volumes per acre (fig. 1, table 3) in all single-product classes — 3,500 fbm of saw logs, 3,300 fbm of veneer logs, or 1,800 fbm of stud logs, which probably reflects the fact that Custer State Park includes some of the eastern "fringe" timber of the Black Hills ponderosa pine type with more open stands. The overall quality of the Custer State Park timber stand is higher, however (table 3), as indicated by higher proportions of saw log grades 1, 2, and 3, and veneer log grades 1 and 2. This higher quality may reflect past management practices in the Park, which limited cutting largely to sanitation salvage operations, thereby leaving the stand with a greater proportion of old-growth "high-quality" stems.

Estimated total cubic volume (pulpwood) in sawtimber and pole timber stands on General

[4]*All board-foot (fbm) volume figures in this report are Scribner scale. Product volumes that have been reduced for visual scaling defects (table 2) are identified as "Reduced scale."*

[5]*Some of the stems classed as poles in the field survey may not be marketable as poles. Height/diameter ratio and red rot were not considered limitations in classifying stems as poles, due to the difficulty of evaluating these characteristics in standing trees.*

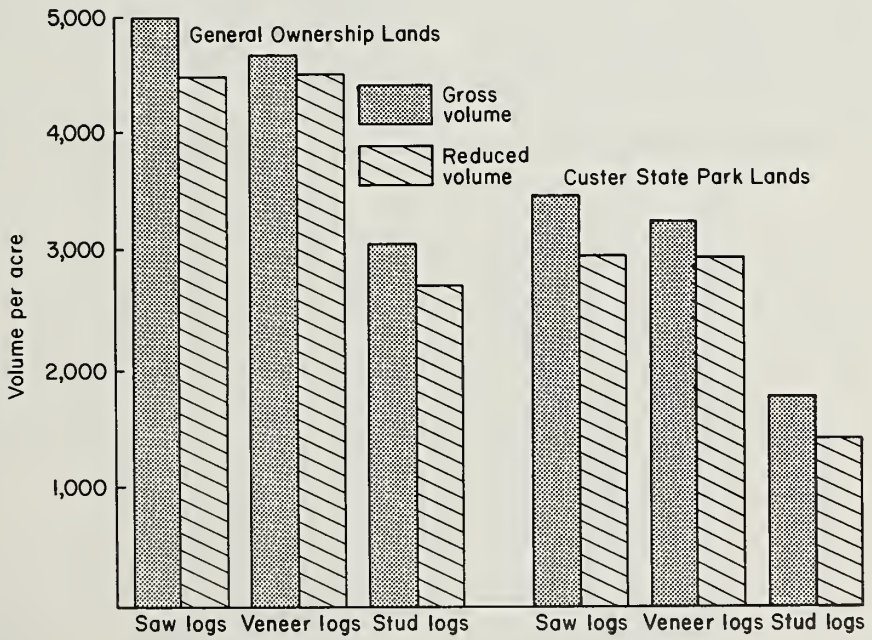

Figure 1. — Comparison of total volume per acre (gross and reduced, fbm, Scribner Scale) suitable for independent products.

Table 3.--Estimated volume per acre (board feet, Scribner scale), by independent product basis and on product priority basis

Tree d.b.h. class (Inches)	INDEPENDENT PRODUCT BASIS						PRODUCT PRIORITY BASIS							
	Saw logs		Veneer logs[1]		Stud logs[2]		Saw logs		Veneer logs		Stud logs		Total	
	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced
	Board feet						Board feet							
	GENERAL OWNERSHIP LANOS													
10	496.52	433.94	536.03	501.35	554.44	479.65	44.97	34.43	367.45	340.47	34.34	1.01	446.76	375.91
12	908.21	813.26	856.02	814.53	788.18	702.00	88.76	72.42	569.54	541.98	34.54	1.23	692.84	615.63
14	1,020.34	919.94	955.70	916.24	748.73	670.26	119.82	98.43	678.61	648.33	36.88	2.89	835.31	749.65
16	867.14	791.22	804.09	788.16	531.92	493.48	143.12	126.16	546.72	535.54	29.69	8.83	719.53	670.53
18	650.31	587.00	603.38	583.46	325.93	290.30	172.89	141.05	383.85	373.09	5.43	0.0	562.17	514.14
20	387.39	365.94	364.10	355.09	90.07	87.57	109.11	101.89	227.60	223.79	2.44	1.22	339.15	326.90
22	253.77	234.83	225.40	224.14	13.03	13.03	98.08	86.87	151.61	150.60	0.0	0.0	249.69	237.47
24	153.57	139.07	141.92	139.35	--	--	44.60	39.42	104.12	101.93	--	--	148.72	141.35
26	107.30	99.60	101.88	101.12	--	--	35.84	32.38	68.19	68.19	--	--	104.03	100.57
28	55.99	54.18	51.51	51.03	--	--	8.31	8.31	43.30	42.82	--	--	51.61	51.13
30	13.61	13.61	13.61	13.61	--	--	4.90	4.90	8.71	8.71	--	--	13.61	13.61
32	30.34	26.19	26.09	21.54	--	--	10.92	6.77	15.17	15.17	--	--	26.09	21.94
Total	4,944.49	4,478.78	4,679.73	4,509.62	3,052.30	2,736.29	881.32	753.03	3,164.87	3,050.62	143.32	15.18	4,189.51	3,818.83
							Percent							
							21	20	76	80	3	<.5	100	100
	CUSTER STATE PARK LANOS													
							Board feet							
10	274.05	224.41	333.71	272.82	330.28	238.65	47.82	35.36	261.33	209.68	26.29	0.0	335.44	245.04
12	563.66	459.29	550.19	472.67	379.28	302.06	156.17	124.71	370.04	317.22	11.57	0.0	537.78	441.93
14	679.10	583.81	635.52	579.60	409.89	341.52	218.20	182.06	345.16	310.71	12.53	0.0	575.89	492.77
16	648.72	548.40	567.05	535.20	354.16	283.83	272.53	213.50	309.33	294.14	20.84	7.04	602.70	514.68
18	490.57	422.43	442.45	421.45	232.31	195.67	233.89	196.44	211.59	206.47	7.46	0.0	452.94	402.91
20	437.83	383.00	388.11	370.36	77.05	69.28	166.88	134.16	222.81	217.16	2.70	0.0	392.39	351.32
22	232.15	210.61	194.07	190.68	11.87	11.57	93.30	78.15	125.97	124.91	0.0	0.0	219.27	203.06
24	97.32	89.96	92.32	87.51	--	--	52.89	47.00	44.43	43.73	--	--	97.32	90.73
26	48.54	45.22	41.00	37.52	--	--	22.66	19.88	22.19	21.59	--	--	44.85	41.47
28	0.0	0.0	0.0	0.0	--	--	0.0	0.0	0.0	0.0	--	--	0.0	0.0
30	7.58	7.58	5.69	5.69	--	--	3.64	3.64	4.02	4.02	--	--	7.66	7.66
Total	3,479.52	2,974.71	3,250.11	2,973.50	1,794.84	1,442.58	1,267.98	1,034.90	1,916.87	1,749.63	81.39	7.04	3,266.24	2,791.57
							Percent							
							39	37	59	63	2	<.5	100	100

[1]Includes grades 1 and 2 veneer logs

[2]Includes only grades 1, 2, and 3 stud logs

Ownership lands was 1,257 ft^3 per acre for 9.0-inch and larger trees, but only 147 ft^3 were left as a residual after the higher valued products were deducted. Similar estimates for Custer State Park lands were 933 ft^3, of which only 126 ft^3 remained after higher valued products were deducted.

Because poles were considered the highest valued potential product, the pole count per acre was the same whether the stands were analyzed for the yield of either a single product or for multiple products under a product priority system (table 4). To more precisely estimate pole values, table 5 (appendix) indicates the number of poles per acre in each d.b.h. class by pole length and estimated top diameter for General Ownership lands.

Detailed data describing volumes per acre by grades for the other products considered are similarly presented in tables 5 through 8 (appendix).

As an example of the kinds of comparisons that can be drawn from these analyses, note that the independent product analyses for General Ownership stands indicate about equal volumes of timber suitable for saw logs and veneer logs (table 3). However, if the product priorities based on potential value are applied, the timber volume allocated to veneer logs is about 3½ times that allocated to saw logs (table 3). These proportions will change any time different product priorities or specifications are used. The usefulness of such information in deciding what products to manufacture or what timber management objectives to establish is apparent.

Conclusions

A multiproduct analysis of the type described here provides the resource manager with qualitative and quantitative information on the timber stand that allows him to realistically evaluate alternative management objectives. Treatments that would emphasize an individual product can be compared against treatments to produce a mix of products, with specific products given priority according to their value.

This type of analysis in the Black Hills indicates that ponderosa pine stands on public (General Ownership) lands contain gross volumes per acre of 4,944 fbm of saw logs, 4,680 fbm of veneer logs, or 3,052 fbm of stud logs if inventoried for these products individually. However, if inventoried simultaneously for highest multiproduct potentials, the same stands would contain gross allocated volumes of 881, 3,165, and 143 fbm per acre for each product, respectively.

By comparison, Custer State Park lands contain smaller gross volumes per acre, but of higher quality. If inventoried for a single product, the stands would contain gross volumes of 3,480 fbm of saw logs, 3,250 fbm of veneer logs, or 1,795 fbm of stud logs. However, if inventoried for multiproduct potential, these stands would contain 1,268 fbm of saw logs, 1,917 fbm of veneer logs, and 81 fbm of stud logs per acre.

These analyses demonstrate the usefulness of multiproduct evaluation techniques in evaluating utilization alternatives. Successful application of the multiproduct inventory and analysis system to Black Hills ponderosa pine

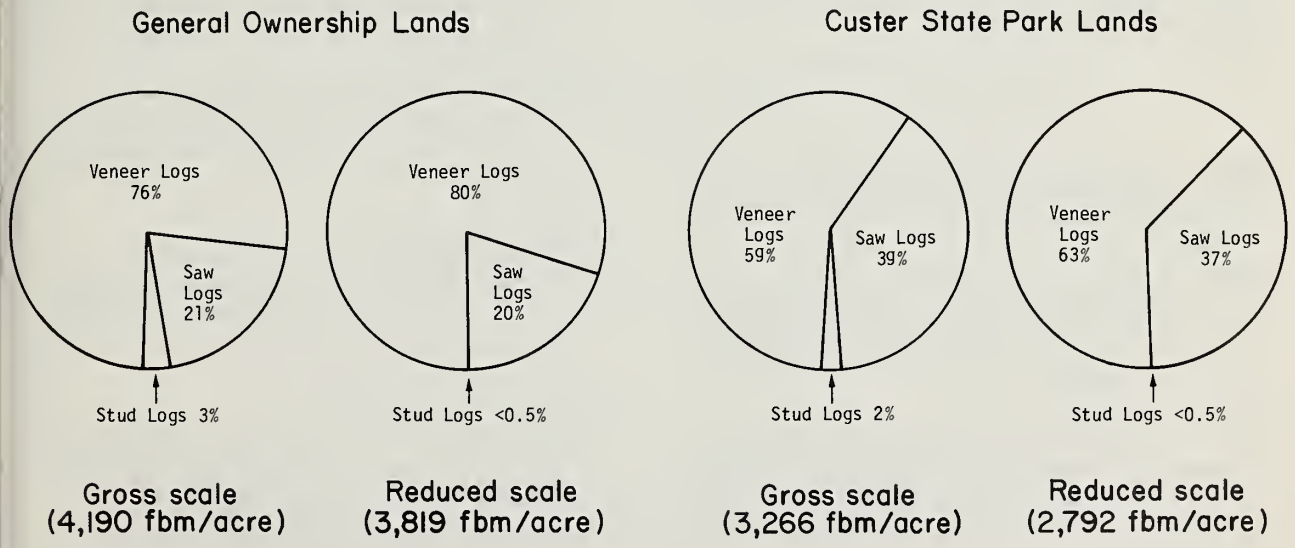

Figure 2. — Comparison of the proportion of Black Hills timber stands suitable for the highest valued individual products.

Table 4.--Estimated number of poles per acre by pole height

Tree d.b.h. class (Inches)	Pole height (ft)										
	15	20	25	30	35	40	45	50	55	60	Total
	GENERAL OWNERSHIP LANDS[1]										
10	0.06	1.85	1.24	0.78	0.10	--	0.01	--	--	--	4.04
12	.06	1.21	.86	.83	.37	0.04	--	--	--	--	3.37
14	.01	.47	.47	.24	.27	.11	--	0.01	--	--	1.58
16	.02	.16	.13	.20	.16	.07	.02	.01	--	--	.77
18	--	.12	.06	.06	.01	--	.03	.01	--	--	.29
20	--	.03	.01	.01	.03	--	--	--	--	0.01	.09
Total	.15	3.84	2.77	2.12	.94	.22	.06	.03	--	.01	10.14
	CUSTER STATE PARK LANDS[1]										
10	--	.37	.81	--	--	--	--				1.18
12	--	.10	.18	.16	--	--	--				.44
14	--	.23	.23	.14	.08	.04	--				.72
16	.03	.06	.09	--	.03	--	--				.21
18	--	.04	.03	--	.02	--	.02				.11
20	.02	.02	.02	.02	.02	.02	--				.12
Total	.05	.82	1.36	.32	.15	.06	.02				2.78

[1] Some of the stems classed as poles in the field survey may not be marketable as poles. Height/diameter ratio and red rot were not considered limitations in classifying stems as poles, due to the difficulty of evaluating these characteristics in standing trees.

stands suggests that any timber resource can be similarly analyzed, using appropriate product specifications and priorities.

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Appendix

Detailed Product Volumes Per Acre — Independent Product and Product Priority Bases

Table 5.--Estimated number of poles per acre by d.b.h. classes, General Ownership lands[1]

Pole height (feet)	Pole top diameter outside bark (inches)														
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
							10-inch d.b.h. class (273 trees)								
15	--	0.040	0.013	0.010	--										0.063
20	0.040	.581	.857	.329	0.044										1.851
25	.084	.541	.487	.111	--										1.223
30	.111	.430	.202	.020	.020										.783
35	.040	.010	.044	.010	--										.104
40	--	--	--	--	--										--
45	--	.010	--	--	--										.010
Total	.275	1.612	1.603	.480	.064										4.034
							12-inch d.b.h. class (224 trees)								
15	--	.010	--	.020	.024	0.010	--								.064
20	.040	.013	.222	.501	.222	.198	0.010								1.206
25	--	.158	.215	.215	.218	.044	--								.850
30	.020	.192	.289	.245	.084	--	--								.830
35	.010	.091	.104	.151	.010	--	--								.366
40	.010	--	--	.030	--	--	--								.040
Total	.080	.464	.830	1.162	.558	.252	.010								3.356
							14-inch d.b.h. class (116 trees)								
15	--	--	--	--	--	.010	--	--	--						.010
20	--	--	--	.067	.111	.124	.087	0.081	--						.470
25	--	--	.020	.030	.094	.195	.081	.034	0.020						.474
30	--	.020	.040	.074	.050	.044	.010	--	--						.238
35	--	.034	.064	.050	.044	.054	.020	--	--						.266
40	.010	--	.050	.030	.010	.010	--	--	--						.110
45	--	--	--	--	--	--	--	--	--						--
50	--	--	--	--	--	.010	--	--	--						.010
Total	.010	.054	.174	.251	.309	.447	.198	.115	.020						1.578
							16-inch d.b.h. class (58 trees)								
15		--	--	--	--	--	--	.020	--	--					.020
20		--	--	--	--	.071	.020	.030	.020	0.020					.161
25		--	--	.024	--	.010	.050	.020	.030	--					.134
30		--	--	--	.040	.044	.030	.054	.030	--					.198
35		.010	.024	.034	.013	.020	.030	.020	.013	--					.164
40		.010	--	.010	.024	.013	.013	--	--	--					.070
45		--	.010	.010	--	--	--	--	--	--					.020
50		--	--	--	--	.010	--	--	--	--					.010
Total		.020	.034	.078	.077	.168	.143	.144	.093	.020					.777
							18-inch d.b.h. class (21 trees)								
20						--	--	.050	.010	.020	--	0.040			.120
25						--	.010	.020	.010	.020	--	--			.060
30						--	.030	--	.010	--	0.010	.010			.060
35						--	--	.013	--	--	--	--			.013
40						--	--	--	--	--	--	--			--
45						.020	.010	--	--	--	--	--			.030
50						.013	--	--	--	--	--	--			.013
Total						.033	.050	.083	.030	.040	.010	.050			.296
							20-inch d.b.h. class (9 trees)								
20									--	--	--	--	0.020	0.010	.030
25									--	.010	--	--	--	--	.010
30									.010	--	--	--	--	--	.010
35									--	.013	.010	.010	--	--	.033
40									--	--	--	--	--	--	--
45									--	--	--	--	--	--	--
50									--	--	--	--	--	--	--
55									--	--	--	--	--	--	--
60									--	.010	--	--	--	--	.010
Total									.010	.033	.010	.010	.020	.010	.093

[1]Some of the stems classed as poles in the field survey may not be marketable as poles. Height/diameter ratio and red rot were not considered limitations in classifying stems as poles, due to the difficulty of evaluating these characteristics in standing trees.

Table 6.--Estimated saw-log volume per acre (board feet, Scribner scale), by independent product basis and on product priority basis

Tree d.b.h. class (Inches)	Grade 1		Grade 2		Grade 3		Grade 5		Total	
	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced
GENERAL OWNERSHIP LANDS										
INDEPENDENT PRODUCT BASIS										
10	0.83	0.65	4.41	3.63	44.07	33.51	447.21	396.15	496.52	433.94
12	4.46	3.51	12.64	9.54	87.31	72.57	803.80	727.64	908.21	813.26
14	8.62	6.62	30.60	22.25	106.40	94.00	874.72	797.07	1,020.34	919.94
16	19.17	18.31	24.03	20.62	122.19	111.78	701.75	640.51	867.14	791.22
18	27.24	24.52	40.30	33.15	117.51	98.06	465.26	431.27	650.31	587.00
20	17.58	14.18	32.31	29.96	62.33	60.74	275.17	261.06	387.39	365.94
22	34.67	28.50	21.32	20.91	35.34	33.41	162.44	152.01	253.77	234.83
24	10.72	8.22	2.98	2.60	27.84	27.30	112.03	100.95	153.57	139.07
26	8.03	7.19	3.32	3.32	24.49	21.87	71.46	67.22	107.30	99.60
28	4.28	4.28	0.0	0.0	4.03	4.03	47.68	45.87	55.99	54.18
30	0.0	0.0	0.0	0.0	4.90	4.90	8.71	8.71	13.61	13.61
32	10.92	6.77	0.0	0.0	0.0	0.0	19.42	19.42	30.34	26.19
Total	146.52	122.75	171.91	145.98	636.41	562.17	3,989.65	3,647.88	4,944.49	4,478.78
Standard error	18.28	15.65	16.14	14.06	49.40	44.28	156.44	147.81		
PRODUCT PRIORITY BASIS										
10	.83	.65	3.81	3.11	40.16	29.76	.17	.91	44.97	34.43
12	3.90	2.95	11.50	8.39	71.76	58.00	1.60	3.08	88.76	72.42
14	7.98	5.98	28.96	20.80	80.21	69.41	2.67	2.24	119.82	98.43
16	17.19	16.33	20.58	17.17	98.00	88.08	7.35	4.58	143.12	126.16
18	27.24	24.52	35.73	28.58	101.92	83.20	8.00	4.75	172.89	141.05
20	15.76	12.82	32.31	29.96	60.44	58.85	.60	.26	109.11	101.89
22	34.67	28.50	21.32	20.91	35.34	33.41	6.75	4.05	98.08	86.87
24	10.72	8.22	2.98	2.60	27.84	27.30	3.06	1.30	44.60	39.42
26	8.03	7.19	3.32	3.32	24.49	21.87	0.0	0.0	35.84	32.38
28	4.28	4.28	0.0	0.0	4.03	4.03	0.0	0.0	8.31	8.31
30	0.0	0.0	0.0	0.0	4.90	4.90	0.0	0.0	4.90	4.90
32	10.92	6.77	0.0	0.0	0.0	0.0	0.0	0.0	10.92	6.77
Total	141.52	118.21	160.51	134.84	549.09	478.81	30.20	21.17	881.32	753.03
Standard error	17.99	15.42	15.65	13.57	43.28	38.13	4.90	2.83		
CUSTER STATE PARK LANDS										
INDEPENDENT PRODUCT BASIS										
10	4.85	4.43	0.0	0.0	45.03	32.16	224.17	187.82	274.05	224.41
12	12.56	10.44	26.29	19.62	117.55	92.09	407.26	337.14	563.66	459.29
14	26.93	20.71	59.98	50.70	149.14	128.41	443.05	383.99	679.10	583.81
16	30.89	22.39	59.66	44.45	188.21	157.18	369.96	324.38	648.72	548.40
18	20.30	15.91	47.06	40.14	170.56	144.53	252.65	221.85	490.57	422.43
20	18.91	13.52	20.72	17.50	129.10	113.00	269.10	238.98	437.83	383.00
22	26.27	22.02	19.17	16.37	41.62	37.28	145.09	134.94	232.15	210.61
24	15.24	12.40	11.05	8.87	23.67	23.10	47.36	45.59	97.32	89.96
26	6.11	4.28	10.16	9.21	6.39	6.39	25.88	25.34	48.54	45.22
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	3.64	3.64	0.0	0.0	3.94	3.94	7.58	7.58
Total	162.06	126.10	257.73	210.50	871.27	734.14	2,188.46	1,903.97	3,479.52	2,974.71
Standard error	30.79	24.89	40.30	33.80	102.86	88.10	192.43	168.36		
PRODUCT PRIORITY BASIS										
10	4.85	4.43	0.0	0.0	42.97	30.61	0.0	0.32	47.82	35.36
12	12.56	10.44	26.29	19.62	114.81	90.04	2.51	4.61	156.17	124.71
14	26.93	20.71	56.70	47.84	132.07	111.34	2.50	2.17	218.20	182.06
16	30.89	22.39	59.66	44.45	173.26	142.66	8.72	4.00	272.53	213.50
18	20.30	15.91	43.54	36.62	165.17	139.14	4.88	4.77	233.89	196.44
20	15.81	10.82	20.72	17.50	110.69	95.09	19.66	10.75	166.88	134.16
22	26.27	22.02	19.17	16.37	41.62	37.28	6.24	2.48	93.30	78.15
24	15.24	12.40	11.05	8.87	23.67	23.10	2.93	2.63	52.89	47.00
26	6.11	4.28	10.16	9.21	6.39	6.39	0.0	0.0	22.66	19.88
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	3.64	3.64	0.0	0.0	0.0	0.0	3.64	3.64
Total	158.96	123.40	250.93	204.12	810.65	675.65	47.44	31.73	1,267.98	1,034.90
Standard error	30.79	24.88	39.11	32.57	95.58	80.54	14.66	8.99		

Table 7.--Estimated veneer-log volume per acre (board feet, Scribner scale), by independent product basis and on product priority basis

Tree d.b.h. class	INDEPENDENT PRODUCT BASIS								PRODUCT PRIORITY BASIS					
	Grade 1		Grade 2		Total		Unacceptable		Grade 1		Grade 2		Total	
(Inches)	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced
						GENERAL OWNERSHIP LANDS								
10	493.84	462.18	42.19	39.17	536.03	501.35	48.39	.41	331.62	307.49	35.83	32.98	367.45	340.47
12	685.97	650.63	170.05	163.90	856.02	814.53	70.38	2.04	438.40	416.15	131.14	125.83	569.54	541.98
14	617.55	587.92	338.15	328.32	955.70	916.24	71.88	1.66	397.38	376.02	281.23	272.31	678.61	648.33
16	433.88	422.99	370.21	365.17	804.09	788.16	66.68	4.55	233.21	226.98	313.51	308.56	546.72	535.54
18	274.01	260.58	329.37	322.88	603.38	583.46	46.93	6.54	115.40	110.99	268.45	262.10	383.85	373.09
20	156.58	149.29	207.52	205.80	364.10	355.09	23.29	2.99	51.24	48.81	176.36	174.98	227.60	223.79
22	90.24	89.99	135.16	134.15	225.40	224.14	28.36	4.72	28.69	28.69	122.92	121.91	151.61	150.60
24	47.91	47.52	94.01	91.83	141.98	139.35	11.66	0.0	14.62	14.62	89.50	87.31	104.12	101.93
26	46.75	45.99	55.13	55.13	101.88	101.12	5.41	1.19	16.60	16.60	51.59	51.59	68.19	68.19
28	10.41	10.41	41.10	40.62	51.51	51.03	4.48	3.19	4.02	4.02	39.28	38.80	43.30	42.82
30	2.72	2.72	10.89	10.89	13.61	13.61	0.0	0.0	0.0	0.0	8.71	8.71	8.71	8.71
32	10.92	6.37	15.17	15.17	26.09	21.54	4.25	4.25	0.0	0.0	15.17	15.17	15.17	15.17
Total	2,870.78	2,736.59	1,808.95	1,773.03	4,679.73	4,508.62	381.71	31.54	1,631.18	1,550.37	1,533.69	1,500.25	3,164.87	3,050.62
Standard error	111.24	107.36	78.15	77.60			21.90	4.87	72.16	69.73	67.62	66.91		
						CUSTER STATE PARK LANDS								
10	265.80	216.93	67.91	55.89	333.21	272.82	46.04	1.10	201.23	160.95	60.10	48.73	261.33	209.68
12	325.27	272.52	224.92	200.15	550.19	472.67	53.76	8.72	173.74	143.32	196.30	173.90	370.04	317.22
14	334.78	296.04	300.74	283.56	635.52	579.60	49.81	8.71	118.68	100.08	226.48	210.63	345.16	310.71
16	278.30	254.59	288.75	280.61	567.05	535.20	93.91	11.48	91.24	81.95	218.09	212.19	309.33	294.14
18	203.06	185.72	239.39	235.73	442.45	421.45	50.14	11.42	41.99	39.14	169.60	167.33	211.59	206.47
20	143.27	130.35	244.84	240.01	388.11	370.36	50.72	12.92	35.17	33.48	187.64	183.68	222.81	217.16
22	66.59	63.81	127.48	126.87	194.07	190.68	39.08	12.90	17.53	16.47	108.44	108.44	125.97	124.91
24	39.77	34.96	52.55	52.55	92.32	87.51	4.99	4.66	2.96	2.26	41.47	41.47	44.43	43.73
26	15.07	12.52	25.93	25.00	41.00	37.52	7.54	7.54	3.19	3.19	19.00	18.40	22.19	21.59
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	1.67	1.67	4.02	4.02	5.69	5.69	1.89	1.89	0.0	0.0	4.02	4.02	4.02	4.02
Total	1,673.58	1,469.11	1,576.53	1,504.39	3,250.11	2,973.50	397.88	81.34	685.73	580.84	1,231.14	1,168.79	1,916.87	1,749.63
Standard error	151.87	138.45	134.74	131.93			42.00	18.41	81.53	70.56	109.46	106.08		

Table 8.--Estimated stud-log volume per acre (board feet, Scribner scale), by independent product basis and on product priority basis

Tree d.b.h. class (Inches)	Grade 1		Grade 2		Grade 3		Total		Unacceptable	
	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced	Gross	Reduced
GENERAL OWNERSHIP LANDS										
INDEPENDENT PRODUCT BASIS										
10	194.91	166.94	323.10	281.93	36.43	30.78	554.44	479.65	18.06	12.35
12	270.62	233.81	445.78	403.79	71.78	64.40	805.39	702.00	71.74	54.53
14	296.37	251.17	360.88	334.32	91.48	84.77	748.73	670.26	133.18	115.13
16	248.54	226.75	210.98	200.49	72.40	66.24	531.92	493.48	159.22	145.01
18	187.89	162.29	111.00	102.63	27.04	25.38	325.93	290.30	146.29	135.08
20	44.15	43.19	33.04	32.12	12.88	12.26	90.07	87.57	66.28	61.84
22	4.82	4.82	5.76	5.76	2.45	2.45	13.03	13.03	30.39	28.40
Total	1,247.30	1,088.97	1,490.55	1,361.04	314.45	286.28	3,052.30	2,736.29	625.16	552.34
Standard error	61.91	54.80	76.40	71.86	15.52	15.26			28.00	25.09
PRODUCT PRIORITY BASIS										
10	12.46	.46	18.92	.48	2.96	.07	34.34	1.01		
12	9.20	.74	21.32	.49	4.02	0.0	34.54	1.23		
14	21.39	1.37	12.81	1.52	2.68	0.0	36.88	2.89		
16	13.44	3.96	10.66	4.20	5.59	.67	29.69	8.83		
18	2.81	0.0	2.62	0.0	0.0	0.0	5.43	0.0		
20	0.0	0.0	1.19	.60	1.25	.62	2.44	1.22		
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Total	59.30	6.53	67.52	7.29	16.50	1.36	143.32	15.18		
Standard error	7.65	1.81	5.95	1.73	1.74	.38				
CUSTER STATE PARK LANDS										
INDEPENDENT PRODUCT BASIS										
10	111.14	71.07	189.19	143.49	29.95	24.09	330.28	238.65	42.15	27.96
12	184.83	139.48	160.06	133.04	34.39	29.54	379.28	302.06	172.07	128.82
14	204.15	166.39	155.85	129.66	49.89	45.47	409.89	341.52	162.55	135.20
16	205.38	156.16	122.86	106.29	25.92	21.38	354.16	283.83	165.60	147.16
18	152.22	128.99	70.77	57.36	9.32	9.32	232.21	195.67	125.19	113.20
20	34.43	28.66	29.69	27.69	12.93	12.93	77.05	69.28	101.14	94.80
22	5.08	4.78	6.79	6.79	0.0	0.0	11.33	11.57	28.95	26.42
Total	897.23	695.53	735.21	604.32	162.40	142.73	1,794.84	1,442.58	797.65	673.56
Standard error	96.62	78.69	82.86	70.50	16.22	15.46			70.93	60.77
PRODUCT PRIORITY BASIS										
10	8.37	0.0	17.18	0.0	.74	0.0	26.29	0.0		
12	5.42	0.0	3.42	0.0	2.73	0.0	11.57	0.0		
14	0.0	0.0	10.80	0.0	1.73	0.0	12.53	0.0		
16	9.58	2.14	9.18	4.16	2.08	.74	20.84	7.04		
18	1.50	0.0	5.96	0.0	0.0	0.0	7.46	0.0		
20	1.39	0.0	1.31	0.0	0.0	0.0	2.70	0.0		
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Total	26.26	2.14	47.84	4.16	7.29	.74	81.39	7.04		
Standard error	5.99	1.54	8.99	2.30	2.56	.53				

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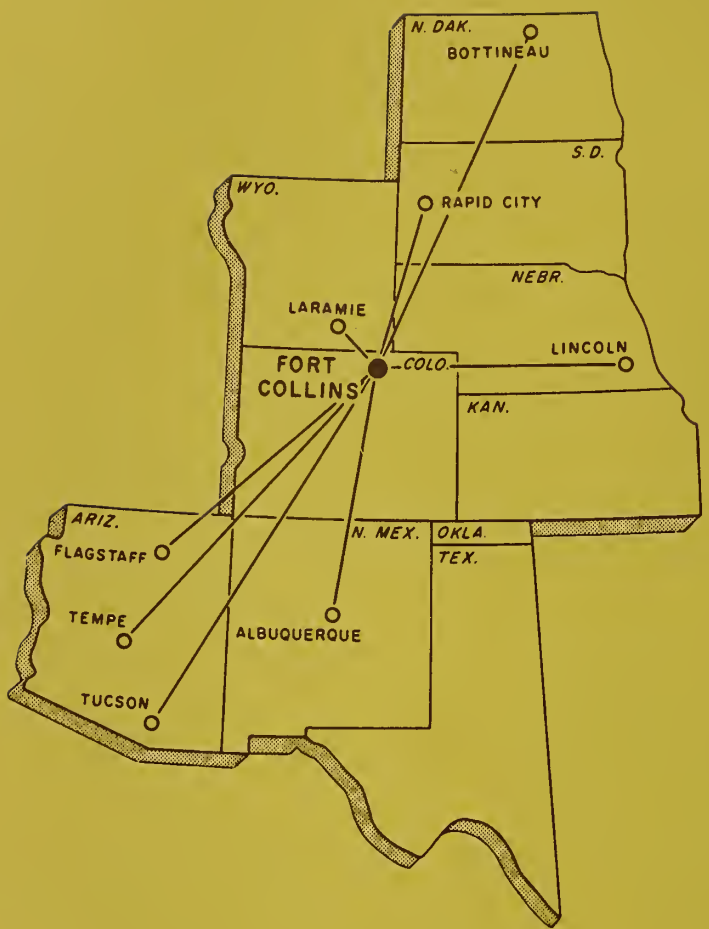
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